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University Students Promoting Science in the Community

Susan P. Bruce and Bertram C. Bruce

When two university science students[1] walk into the Boys and Girls Club in a small Midwestern city one afternoon, they represent a world distant from that of the young children who come running off the basketball court to ask: "What are we doing in Science Club today?" This day, their second visit, the students encounter a few familiar faces, but most of the 6-to-9 year olds are new to them. They are going to teach the children how to make kites, but first they talk about how airplanes fly. They draw an airplane wing on the white board and introduce the name Bernoulli. To forestall fidgeting, the young woman, who is studying biochemistry at the university, asks the children to say in unison "Ber-noul-li." She tells her partner, a history major with a minor in chemistry, to demonstrate the Bernoulli principle, by blowing across a penny to lift it into a beaker lying on its side. The children follow suit, blowing pennies into a paper cup. Then they all get down to the entertaining business of making kites.

Upstairs, two undergraduates in chemistry and biochemistry are drawing children into the Computer Club. When a second announcement fails to attract a quorum, the Boys and Girls Club's supervisor wanders down to the ping pong tables to hustle up more participants. Last week the students let the children explore on the Web, finding Web sites that interest them, but this week they plan to do some "typing." They want the children to learn a few basic things about word processing. The students express doubts that tiny Taneka, a first grader, can "type" and the supervisor agrees, but he thinks that 8-year-old Tony is up to it. Taneka is given an errand to do. The students ask the remaining nine-to-thirteen year olds to write something about themselves. As the children struggle to think what to say, the two young men circulate around the lab, offering suggestions---"Do you like pizza? Then write that,"---pointing out the shift key and punctuation when needed. Though it is 4:00, it looks and feels like school in this computer lab.[2]

Project SEARCH (Science Education and Research for Children) has brought these undergraduate students here today. It is an outreach program designed to bring the science resources of a large research university to classrooms and community centers. For the past 9 years, SEARCH students have spent 4 hours each week doing hands-on-science experiments, dissecting frogs, demonstrating microscopes, lecturing about the planets, playing computer games, exploring the World Wide Web, and creating Web pages.

Watching Project SEARCH students at work in a variety of settings around the community, an observer might well ask: What kind of science or computing skills are they

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1 In this article, "student" indicates a university undergraduate and "child" indicates an elementary or middle school student.

2 Portions of this chapter were drawn from "Constructing images of science: people, technologies, and practices." (Bruce S. & Bruce, B.C.,2000)

bringing to the children involved? Is there learning going on? Is it fun? When they work during the after-school hours, as these students are doing with mixed success, what special skills, materials or attitudes towards science can they offer? What about SEARCH continues to attract university students, after-school programs, and teachers? How do we make sense of a program with such interesting strengths and limitations? What can we, or should we, expect of enrichment activities such as these during the after school hours? In the end, what does the SEARCH experience tell us about the relation of universities to the diverse communities in which they reside?

BACKGROUND

Project SEARCH was developed out of a desire to provide a meaningful service learning opportunity for university science students and to help the community improve science education for children. There were three underlying assumptions: (1) to bring about positive change in education, *there must be collaboration*—between scientists and educators, between schools and universities, among university students and faculty, between classroom teachers and university students, and among children in the classroom; (2) *children learn science best when given the opportunity to ask questions, explore phenomena, construct their own theories, and express their developing understandings in language that is meaningful to them;* and (3) *the development of positive attitudes toward science learning is a critical element in bringing about the engagement of students in learning*. This is especially true for the many girls and minority students who have often been excluded from full participation in scientific and technical arenas.

These themes can be seen in many projects, but SEARCH adds another and somewhat unique dimension: the science resources, expertise, and activities are offered by undergraduate science majors. These students are viewed as learners, not simply as experts, and the teachers or community staff with whom they work are seen as learners as well.

We have worked with Project SEARCH for most of its life and conducted a formal evaluation (Bruce, B. C., Bruce, S., Conrad & Huang, 1994), focusing on the overall impact of the program, and the responses of students, teachers and children to their participation. Project SEARCH grew steadily during its early years, from 19 students in the fall of 1992 to a high of 122 in the spring of 1998. The number of participating teachers increased from 10 to 22 during that time period, and the number of children grew from approximately 200 to 550. As SEARCH enters its 10th year, participation has dropped somewhat from that high, to 38 students in the spring of 2001. Nevertheless, the program continues to attract students, schools and after-school programs, and to endure within the institution of the university.

Combining student data across three years from 1992 to 1995, when we completed our evaluation, we found that 53% of the participating students were female; 5% of the students were African-American, 4% were Latino, 36% were Asian or Pacific-Islander, and 56% were White. The ethnicity of SEARCH students is roughly comparable to the enrollment in the science departments. However, the participation by women is somewhat higher than in the science disciplines as a whole. It is tempting to attribute this to the social service aspect of SEARCH, but it may be due to other factors, such as different career aspirations for which participation would be beneficial. One female student told us,

> I am taking this course for various reasons. I believe that improving my interactive skills with children will help me to be a better doctor and parent. I also enjoy the chance to share my science knowledge with people who will be interested and benefit from it. I remember when I was in grade school. We didn't even open a science book until 6th grade. Of course, my most selfish reason is that Project SEARCH is a lot of fun.

Most SEARCH students work during the school day in elementary-school classrooms, almost always with a teacher present or nearby. Thus, our initial evaluation focused on school-day experiences, though we did observe in after-school programs and a summer science camp, and interviewed students who worked in those informal education settings. Recently we turned our attention to the very different situations that can be found in after-school programs, not for a formal evaluation, but for a more speculative consideration of the effects of a project like SEARCH on the "After 3 PM" learning environment (Bruce & Bruce, 2000).

For the purposes of this chapter, we would like to clarify that "Science", within Project SEARCH, encompasses a range of explorations and often includes computer activities---using computers as tools to do science, learning how to use computers in a computer lab, and learning about new information technologies such as magnetic resonance imaging (Bruce, Thakkar, & Hogan, 1999). When we began our observations, SEARCH students were just beginning to use email in a very limited way and web resources were often unavailable in the classrooms where they worked. Today SEARCH has a fairly active web site[3], with a database of activities for students to adapt, links to teaching resources, and logistical details for the coursework. Most teaching sites have at least one or two computers tucked into a corner, and many have computer labs with multiple workstations. The after-school program at the Boys and Girls Club now includes a well-equipped lab with a dozen computers, since it serves as the site of one of several community networking projects[4].

Program Structure

Through the SEARCH project, pairs of undergraduate science majors develop and present hands-on science and computer activities for children once or twice a week. An attempt is made to pair "repeater" students who have joined the program for a second semester with less-experienced students, particularly for after-school projects. In regular classrooms, the timing, format, and degree of integration of the projects with the curricula is primarily determined by the teachers, but in the after-school programs the students are largely on their own. At the end of each semester, the students develop original science lessons, which then become materials for use by future participants.

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3 Project SEARCH: http://bmrl.med.uiuc.edu:8080/SEARCH/new.

4 Prairienet: http://www.prairienet.org/about/cnioverview.phtml.

The students meet monthly with the program coordinators for an evening class. They report on the activities they led during the previous month, raise problems they have encountered, and listen to presentations by their classmates about programs they have developed. Occasionally, teachers or university faculty present mini-lessons on teaching and graduate assistants share projects developed by previous SEARCH students. But most of what the students learn about teaching and about children happens on site, with the support of staff or teachers in the classrooms, as they begin to work in the community.

SEARCH After 3 P.M.

When compared to the more formal learning settings of elementary school classrooms, SEARCH in the after-school hours presents a somewhat different picture. However, as in the classrooms, the great variety of settings remains a factor in deriving easy generalizations about the program. Each of the out-of-school sites[5] presents unique challenges and possibilities, reflecting different cultural systems (Cole, 1996). Consider the realization (Bruce & Peyton, 1993; Bruce & Rubin, 1993) of SEARCH in four of these: a Boys and Girls Club, two public schools, and a private school science camp.[6]

The Boys and Girls Club is a large local organization, serving over 1,400 children a year with programs in recreation, leadership training, and after-school learning activities. Most of the regular visitors are African-American children of elementary and middle school age. Several of the minority students enrolled in SEARCH have elected to work at the Boys and Girls Club because, as one young woman wrote,

> I feel a need to help black youth by exposing them to the sciences. When I was growing up, I was discouraged from developing a scientific background. Although I expressed a strong interest in the sciences, I was not allowed to do as I wished. I do believe that this was done because I was black (I went to predominantly white parochial schools all my life.) I do feel that the black youth are not prepared for university level studies (as I wasn't), so I elected to take this class on the condition that I would be able to go to the Boys and Girls' Club.

As an indication of the high value placed on SEARCH, when a new building was planned several years ago, a science room and a computer lab were integrated into the addition, partly because of the promised presence of SEARCH students on a regular basis. Some children spend every afternoon at the club, and others drop in from time to time. They are free to choose whatever activities they would like; once they've signed into the computer lab, they are supposed to stay the entire time, but this is a rule that is loosely enforced. No one supervises the university students' activities, except for occasional technical assistance. Much of the time they are entirely on their own.

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5 Not all of the sites described here are active each semester, but they are representative of the kinds of settings we have observed. Over the past several years, the energies of students and staff have been directed to sites where they believe they can be most effective.

6 The multiple realizations of an innovation are evident, for example, in the various issues of Password Express <http://www.klick.org/>, a weekly newsletter about the KLICK! (computer clubhouse) project.

A second site, in a local elementary school to which SEARCH students have been invited, presents a very different picture. Children here are invited to a classroom to do science activities one or two days each week for the entire semester. The children are seated at desks for much of the time, the students learn their names, and the after-care supervisor occasionally drops by to check on their activities.

A third site can be found at another elementary school that has contracted with a private company to run their after-school program for the past several years. The SEARCH students are welcome to participate, but they must fit into the given daily schedule, which means that their first hour is often spent helping children with homework in the lunchroom where the program is housed. After a break and snack-time, there is time to do science, but often a very limited amount of time.

At the fourth site, a private school runs a summer science camp and an after-school program where SEARCH students lead activities. Many of the participating children have academic parents, and a number of those parents are science professors who often bring in enrichment materials. The students who assist must find activities and software that might be novel to children who have had many prior learning opportunities, and they must be vigilant that they are conveying the correct scientific information, while paying careful attention to the high expectations of adults in this setting.

Though these four sites vary greatly in terms of their structure, the profile of participating children, and the support of a supervising adult, at each the students face a challenge common to all informal learning environments: they must choose activities that are immediately engaging, that are accessible to children across a range of ages, and that are not dependent on the structure provided by a teacher and school-day norms of behavior (Hein, 1990). They must, in short, be fun. And yet the students are there to teach science. One student told us,

> While playing a Geo Safari game with one of the children, I tried to point out some of the things that the game was trying to teach, but the child said that she didn't want to learn anything and just continued to guess randomly at questions that were asked.

Another student was frustrated to be working “only with computers,” and would have preferred to be doing science:

> I am working with computers, and have come to the decision that I would prefer to be doing actual science projects because most of the children I am working with have had a lot of experience with computers and I feel like I could teach them more with science projects.

Yet another reported,

> For me, it is a more difficult task to teach because firstly, it's Saturday and the kids usually want to play, or watch TV, or run around, not get lessons in science. That forces me to find creative projects that require hands-on work that looks like fun.

An undergraduate who has become very immersed in SEARCH after several semester’s participation and is now the project coordinator wrote:

> Definitely the HANDS ON ACTIVITIES work best... I found that doing experiments that let them take home things or have their own were great. It was also helpful to apply/ compare the "science" to everyday things. We did the flow of the heart as one and my partner and I both drew a big picture of it in the parking lot and had the kids pretend to be oxygen/blood. Worked Well!! We grew plants and talked about seeds, plant circulation and photosynthesis. We also talked about electricity and did a fun project to light up a pickle and then gave the class pickles (an unusual request but it got them interested).

Comments such as these have confirmed our observation that resolving this tension between the demands of the environment for engaging the learner, and the students' conception of what it means to teach science is one of the critical challenges faced by a program like SEARCH, particularly during the after-school hours.

IMAGES OF SCIENCE AND SCIENTISTS

As part of their mission statement, the developers of SEARCH write:

> It is our hope that we will learn how better to reach out and touch children from all ethnic groups and of both genders with the excitement and significance of science in ways that will enrich their lives and broaden their choices of educational paths and careers.

Underlying this vision is the assumption that the university possesses rich resources of knowledge and materials not present in the community. There is further the implication that science learning will improve if these resources can be brought to bear in the schools, clubs, and after-school programs.

This conception positions science as the special province of the university, which can now be shared with the community. To some extent, we saw that vision realized, and indeed, many teachers rated highly the tools, objects, materials, and expertise they obtained through SEARCH. But as we observed in more settings and saw more clearly both the strengths and weaknesses of the project, we came to understand that the major effect was not in terms of science resources or even science learning per se. In fact, the undergraduates often brought constructed modes of learning that were stereotypical and limited in scope relative to what the children already experienced in their schools. The major benefits of SEARCH may lie, not in those activities as such, but in the image of science as a human activity, which the project presents.

How Do Children Become Interested in Science?

Students who work in the SEARCH program are a diverse group, but one common characteristic is that they are interested in science. We asked SEARCH students how they developed that interest. A fairly typical response was this,

> The most significant experience with science I had before age 12 was definitely my fourth grade science fair project. My father helped me to build and understand a solar heater. It was a simple project, yet I learned a vast amount about the effects of light

> energy. I also remember asking significant questions in order to understand what it was that I was actually doing.

This linking of learning and enjoyable activity is increasingly recognized as critical for the development of positive attitudes about learning science and technology, as Jarrett points out:

> Play and science are often thought of as opposites, with play representing frivolity and science representing serious logical thinking. But for many eminent scientists, play was an important part of their childhood, and continued playfulness marked their scientific careers. (1996, p. 32)

One of the students reported,

> I learned more about science from my family, television, and Girl Scouts than I did in a classroom. But it was enough to induce me into pursuing it as a career.

Responses like these show clearly that science interest did not arise solely, or even primarily, out of the standard classroom setting for these students. Moreover, it invariably depended upon personal interactions with a family member or friends.

Students were aware that the children did not think of themselves as likely ever to participate in the scientific community. One said,

> Having participated in Project SEARCH for over a year now, I know that elementary school children define science in a very broad way. Science is everything that surrounds them--nature, weather, animals, and technology (although they don't necessarily describe it in those terms).

The children had broad interests in learning all sorts of things, but typically saw that as not representative of what scientists really do. One reason for this is that many had no alternative models. Their parents were rarely in any way involved with scientific or technical careers, and few of their parents had studied any science past the minimum required in school. Fewer still had the experience of Nobel Prize winner Richard Feynman, whose stories about his parents resonate with those of the SEARCH students: "My father taught me to notice things…no pressure–just lovely, interesting discussions. It has motivated me for the rest of my life, and makes me interested in *all* the sciences."

In contrast, many of the children had few science experiences and most had never been to the university, despite the fact that it is a dominant feature in this community of 100,000 people. During one semester, the SEARCH project held a science fair on campus. This was the first visit to any university for many of the children, although a number of them didn't know afterwards that the building housing the science fair was actually part of the university. This distance from university life and science practice meant that science was often seen as the stereotypical portrayal of movies and television. Most importantly, it was not seen as a fun activity that they were allowed to participate in.

A Popular Image of Science

A film such as the 1999 production *Phantom Menace* represents well a popular image of science and technology. In the movie, the forces of both good and evil use unnecessarily elaborate, expensive technology for explosives, light swords, and ray guns. Most of the non-destructive devices are also tools of war: force fields, high-speed rockets, and devices for both seclusion and spying. Curiously, many of the less war-like tools, such as those for communication and daily life, are less advanced than those of today. The movie presents nearly all of these technologies as magic. In fact, the narrative function of technologists in the movie is identical to that of wizards, leprechauns, and good fairies in other genres.

The viewer's role in the *Phantom Menace* is to be either a potential victim of these technologies or, through identification with the heroes, to be a successful user of them. In that sense, it is not so different from the usual representations of science in newspapers, magazines, television, and radio. There is no role for the viewer either as one who constructs such magical devices or as one who could understand the principles underlying their operation. The film confirms the popular view that scientists work far away in laboratories on dangerous or forbidden topics. Their work is opaque to the ordinary person, and not a believable aspiration.

The Image of Science in SEARCH

In contrast, another recent film, *October Sky*, presents a less familiar and more authentic image of science. Here, too, there are rockets and explosions, but the setting is realistic; it is, in fact, based on actual events. The characters struggle against opposition from their families and the community. They also work to understand the principles required to launch a successful rocket. Repeated failures, discouragement, desire to learn, the excitement of the successful launches, and eventual recognition provide a narrative thread, but these activities also have strong analogues in the daily practices of science today. Moreover, because the heroes of the film are working class students who had scant prospects of attending college, their predicaments must seem less remote than those of the typical movie scientist, particularly since we rarely see them actually work, if we see them at all.

Like the protagonists of *October Sky*, SEARCH students are young and some are working class. Their culture and gender diversity allows them to be seen, like the children, as not automatically part of the science and technology elite. They come to the after-school settings wearing blue jeans and t-shirts, with baseball caps turned backwards. Their discourse does not differ greatly from that of children. As we watched them work, we concluded that one of the greater benefits of the project may be the simple presence of a very diverse group of student-scientists in the classroom.

Technology and science, when they are not mysterious and remote, appear to many children as formalistic, unconnected, irrelevant, and heavily dependent on mathematics. But SEARCH presents science as playful, fallible, personal, and collaborative. There is a lot of talk, writing, and drawing. Every aspect is something that children can participate in, and the presence of the SEARCH students validates that people like themselves can become part of the science and technology communities. Instead of light swords, with impossible properties and unexplained functions, the SEARCH students help children make oobleck or find music on the Web.

Children's Changing Constructions of Science

In order to ascertain what the children's images of scientists might be, and how the presence of a science student in their classrooms might have affected those images, during our evaluation we asked them to draw a scientist and talk about their drawings. This led to some of the most interesting observations about the promise and limitations of a project like SEARCH.

On the whole, children adopted the popular stereotype of scientists as people wearing lab coats who "mix chemicals, mix things". This was evident in their drawings: twelve of 21 third-grade children drew a scientist doing a chemistry experiment, often involving explosions, as shown in Figure 1. In a fifth-grade class, four showed a scientist with a lab coat; two wore glasses; four included a lab setting with beakers, test tubes, and clipboards. Only one drawing showed a scientist doing field work—digging dinosaur bones at an archeological site. But children often gave the scientists in their drawings the names of the SEARCH students working in their classrooms, or drew their scientists doing an activity that the children remembered from SEARCH. In Figure 2, for example, a drawing by a fifth grade boy shows the male student who worked in his classroom getting ready to dissect a frog.

In fact, most of the children called the SEARCH students "scientists," although many weren't certain what a scientist was. Many had difficulty coming up with a definition or even a reference to a media scientist. One first-grade girl, however, said that "scientists make things and do stuff that is real neat. Do stuff with different kinds of things. At the University." She then referred to the example of the students who did a liquid nitrogen demonstration at the science fair.

When asked to draw a picture of a scientist, one girl in kindergarten asked, "Can a kid be a scientist? I'm a scientist, I try to figure things out." She then drew a picture of herself, walking her dog. In her K-1 class, the other children most often drew one or both of the SEARCH students. One first-grade girl asked, "Does it have to be a girl?" She said she asked this because one of the SEARCH students was "a girl."

Figure 3 shows a drawing by a fifth grade girl that was typical of several of the drawings and comments made by students at this age, showing a female scientist doing an experiment on water quality. Four other fifth graders refused to make drawings, because they said, "a scientist could look like anybody."

Figure 3.1. A third-grade boy's drawing of a scientist.

Figure 3.2. A fifth-grade boy's drawing of a SEARCH student in his classroom preparing to dissect a frog.

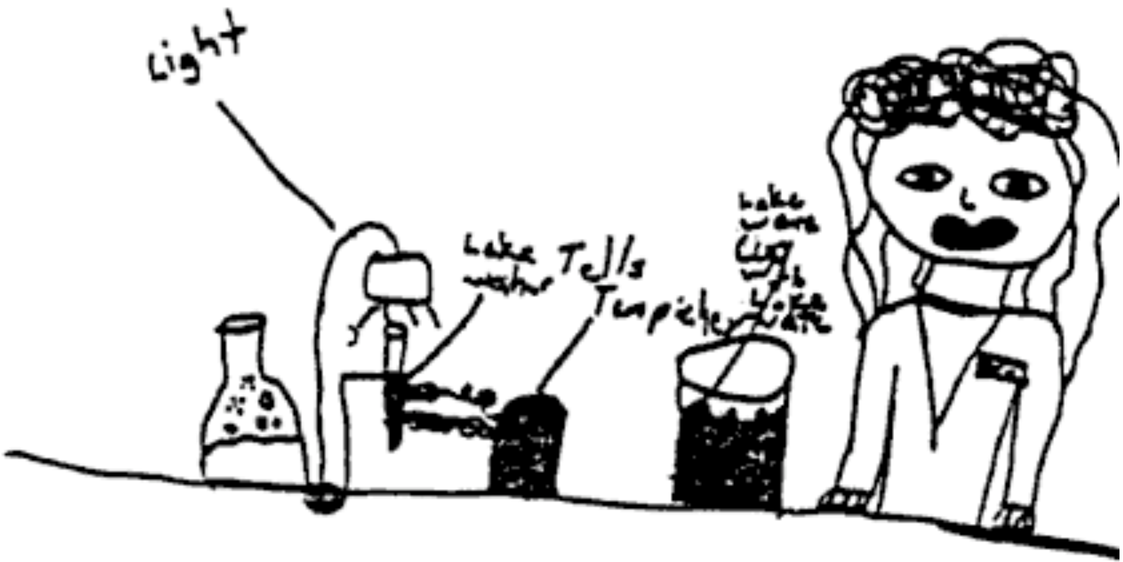

Figure 3.3. A fifth-grade girl's drawing of a female scientist

This interview with a third-grade boy reveals some typical attitudes. Note the reference to "chemicals" and "white jacket," but also the merging of that stereotype with an understanding of what the SEARCH students are like:

Question: This is the scientist you drew, do you want to tell me more about it?

Child: O.K. It's like, it goes to university, it works with chemicals, or stuff like that, medicine, it really likes animals, and its name is Peter. And he teaches science class. He does lots of experiments, he likes to try things out. I can't think anything more.

Q: Why do you name this scientist Peter?

C: Because I go to science class after school on Tuesday, and one of the teachers is Peter. (Do you think Peter is a scientist?) Yes.

Q: Is this special clothing for a scientist?

C: A special one, like a doctor wears a white jacket, you know, that's what he supposed to be. (Why does he need a special jacket to wear?) Like if he observes something, he doesn't spill on his clothes, like poison or something.

Q: What is this scientist doing now?

C: He sees somebody and he waves to him, and he is getting ready to go to observe something.

Q: Have you seen any other scientists?

C: I am not sure if they are all scientists, I know four people [at the university], Steve, Peter, Kevin, and Anna, they are scientists. Yeah, I think they are scientists.

Interestingly, every student we interviewed indicated that they had learned from the project. They learned how to present ideas and phenomena to young children; they gained teaching experience, communication skills, organization skills in designing activities; and they became more creative in developing activities. Perhaps more notably, they also believed it strengthened their knowledge of science. One related that actually setting up experiments was something new for him,

> I actually learned something about science. This was because I had to teach kids. Things like bacteria. I know the stuff about bacteria, but I never set up experiments, I never made agar, you know, little things like that. Now I know how it's done.

Another said, the experience helped her "see if I can actually use what I have learned." Yet another talked about how this experience might affect his future career as a teacher:

> [I am considering] possibly teaching, I am not sure. I enjoy students. I have a lot more responsibility, it helps me grow and learn a lot more. I've always been a student all my life, and now I feel like I crossed the line. If I didn't do this before, and I went on with my life... I don't know if I want to be a teacher, but] this is very positive experience. It encourages me.

One said,

> I have improved my ability to effectively communicate with children and have had my eyes re-opened to the intellectual abilities of the young. It has also helped to strengthen my basic science base due to the fact that I often need to review specific subject matter before attempting to teach it in class.

Finally, one student saw the limitations of his university science learning experiences,

> For myself, I truly realize how much I do and do not know. The questions they ask are sometimes very vague. In being able to answer those questions, I learn myself, through the overall thinking process.

Linking Inquiry with Community Service

With all of the participants----students, teachers and children---- becoming active learners, SEARCH can be seen as a project that links inquiry with community service in a way that recalls the progressive education movement. Progressive educators in the early half of the twentieth century saw the rapidly changing social fabric as both a challenge and an opportunity for democracy. They understood that democracy means active participation by all citizens in social, political and economic decisions that affect their lives. Inquiry was then not simply the process whereby an individual learns, but the means for a democratic society to continually renew itself.

One key tenet was respect for diversity, meaning recognizing each person for his/her own background, abilities, interests, ideas, and cultural identity. This principle has been realized by SEARCH through its emphasis on meeting the needs of children who have not been well-served by the university, the scientific community, or society at large. This has led, especially in the after-school component of SEARCH, to a "child-centered" pedagogy.

Progressive educators also saw the need to develop a critical, socially-engaged intelligence. As Freire (1968) argues, such an intelligence enables individuals to participate in both understanding and changing their world. In the work of Freire, Dewey, and other major theorists, the child-centered and critical aspects of learning are seen as being necessarily related to each other (John Dewey Project on Progressive Education, 2001.) Together, they foster an attitude toward life that is experimental, questioning, and built more upon actual experiences than on tradition, authority, or established curricula. Lucy Sprague Mitchell, one of the founders of Bank Street College expressed this well:

> Our aim is to help students develop a scientific attitude towards their work and toward life. To us this means an attitude of eager, alert observations; a constant questioning of old procedure in light of new observations; a use of the world as well as of books as source material; an experimental open-mindedness; and an effort to keep as reliable records as the situation permits in order to base the future upon actual knowledge of the experiences of the past. (Lucy Sprague Mitchell, quoted in Bakken, 1999)

SEARCH provides an opportunity for university students to extend their learning in the direction of topics that interest them. At the same time, it encourages them to participate actively in changing their world, rather than keeping their learning cloistered away from the community. For the children, their activities begin to include aspects of meaningful inquiry that allow them to participate more fully in their world. These features of SEARCH may lead to inconsistencies, lack of coherence, and uneven success; at the same time they make participation more meaningful for all involved and cause many participants to feel that the experiences here are not easily found elsewhere.

CONCLUSION

There has been little evidence of a coherent science program in SEARCH; in general, good teachers who bring science activities into their classrooms on a regular basis can still do a better job of presenting a curriculum in which activities build upon one another. This is especially the case when one compares after-school SEARCH to more organized programs. The best materials often come not from the university but from a teacher, when one is involved. In after-school programs, the more novice SEARCH students often struggle to work with little guidance. From these perspectives, SEARCH does not always achieve many of its goals.

The project has other problems. In terms of teaching, many of the students are ill-prepared to work with children, particularly in informal settings. Some replicate the textbook or lecture approach to science teaching that they have experienced in school, despite the fact that these are the methods SEARCH was designed to counter. Most do engage children in hands-on activities, but only a few find ways to build activities out of children’s own interests and questions, or to provide opportunities for children to articulate their ideas in their own words, to reflect on what they're learning, or to participate in constructive dialogue.

This relates to another aspect of this program. The SEARCH students themselves are learners in this project, and it is unrealistic to hold them to a standard of master teaching. Especially because they are learners, it is crucial for them to have analogous opportunities to articulate their ideas about teaching and learning, to reflect on what they're learning, and to participate in constructive dialogue. Unfortunately, the institutional, logistical, and financial constraints often make it difficult to provide these opportunities in a truly profound way.

Nevertheless, in its design SEARCH does embody many of the critical elements of a high-quality service learning program. Students are given the opportunity to do work that is real, sustained, and makes an authentic contribution to the community. They have some occasion to reflect on their activities, during their monthly meetings, through email communication with staff, and with each other, since the two-person teams offer an important opportunity for reflecting on learning and teaching. Many of the students return to the project two, three or more semesters. As they work more with professional staff and with children, they often develop into much better teachers. And, despite the minimal preparation for teaching that they do receive, a number of the SEARCH students are able to function as good guides for scientific inquiry.

Over the course of several years of observations, we have seen increasing evidence that SEARCH can be, in fact, highly successful. Many children, especially in after-school programs, obtain their only exposure to what science can be by learning what science students are like. They get an accessible view of science that contrasts markedly with what they see in the mass media. SEARCH does this, not primarily by raising the level of science activities, but through presenting images of science that afford new paths for identity formation.

We saw this when we examined the contrast between the children's typical images of science and those they experience in SEARCH. At some risk of over-generalizing across a very diverse group of children and an equally diverse group of university students and SEARCH activities, we saw a pattern in the contrast between the popular image of science and that of the project along dimensions of scientists themselves, the practices of science, and the construction of knowledge.

There is evidence that children's attitudes about science, science learning, scientists, and their own roles are changing in positive ways. This was apparent in the interviews, in the scientist drawings, and in the way children were engaged in learning with the SEARCH students. Across a broad scope of settings and domains, children find the activities to be engaging and memorable. The hands-on experiences the project provides for children are often their first opportunity to investigate phenomena in depth, and to construct their own understandings. Through these experiences, the children may ultimately be able to participate more fully in the larger society---and the university realize its mission to contribute more fully to the community in which it lives.

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